

Summary Design Modifications

April 2018

STURGEON RIVER, MI



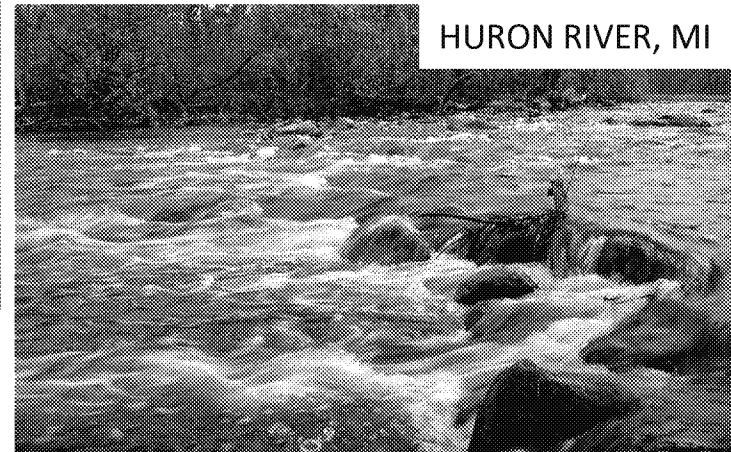
GRAND RIVER, MI



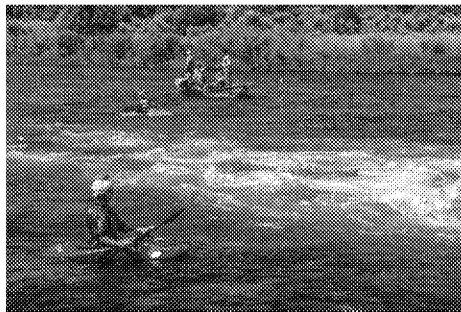
ST. MARY'S RIVER, MI



HURON RIVER, MI



COLORADO RIVER, CO



COLORADO RIVER, CO



Need and Purpose Statement

To the greatest extent reasonably possible, revitalize, enhance, and maintain the rapids in the Grand River in downtown Grand Rapids from above Ann Street to Fulton Street. The revitalization, enhancement, and maintenance of the rapids is expected to facilitate incidental benefits such as expanded public use and access of the river, expanded recreational use of the river, improved aquatic habitat diversity, and improved public health and safety.



Fundamental Design Constraints and Goals

- Constraints
 - Distributing 18 ft of change in water surface elevation
 - Avoid increased flooding
 - Safety for range of user groups
 - Maintain sea lamprey blockage
 - Maintain or improve suitable mussel habitat
 - Maintain integrity of existing infrastructure / public facilities
- Goals
 - Improve aquatic habitat diversity
 - Improve and increase fishing locations
 - Improve natural aesthetic of the river
 - Improve recreation opportunities in addition to fishing
 - Improve circulation and access to the river

DESIGN ALTERNATIVES

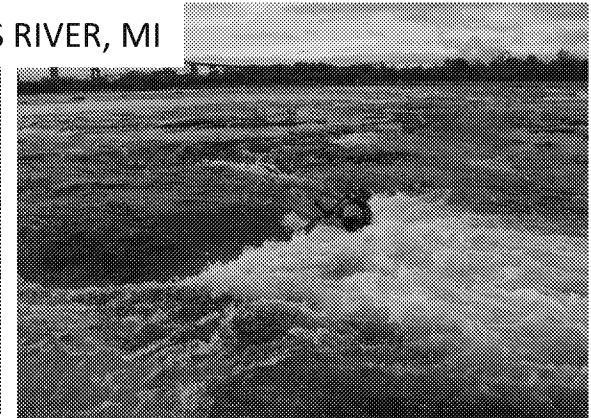
- Alternative 1: No action
- Alternative 2: Increased passage around 6th Street Dam
- Alternative 3: Complete dam removal with no substrate enhancement
- Alternative 4: Remove dams and enhance substrate

EXAMPLES HYDRAULICS

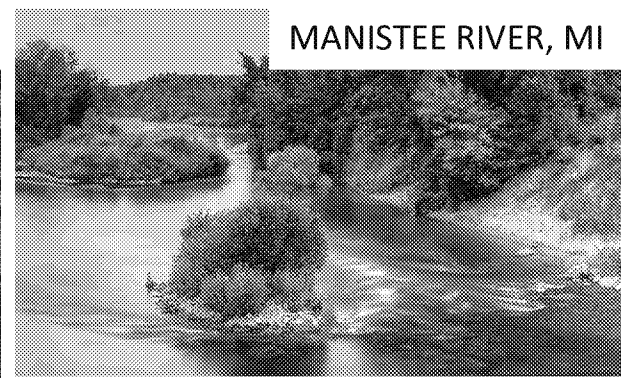
- St. Mary's River: Sault Ste. Marie Rapid
 - Gradient and substrate
 - Riffle, run, wave, boulder garden hydraulics
 - Flow distribution (duel thalweg)
 - Habitat complexity (substrate, velocity, depth)
- Muskegon River, MI
 - Riffle and run hydraulics
 - Habitat complexity (velocity, depth)
- Manistee River, MI
 - Riffle and run hydraulics
 - Habitat complexity (velocity, depth)
- Huron River, MI
 - Gradient and substrate (Delhi Rapid)
 - Riffle and run hydraulics
 - Habitat complexity (velocity, depth)
- Sturgeon River, MI
 - Gradient and substrate
 - Riffle, run, and wave hydraulics
 - Habitat complexity (substrate, velocity, depth)
- Fox River, Kaukauna WI
 - Urban setting
 - Gradient
 - Riffle, run, wave, boulder garden hydraulics
 - Habitat complexity (velocity, depth)



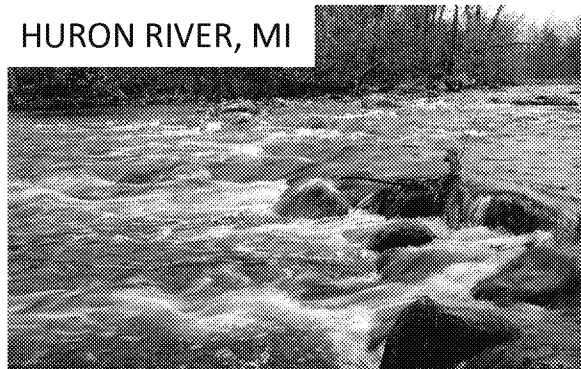
ST. MARY'S RIVER, MI



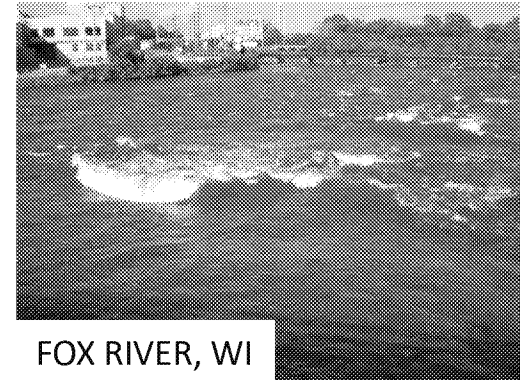
MUSKEGON RIVER, MI



MANISTEE RIVER, MI

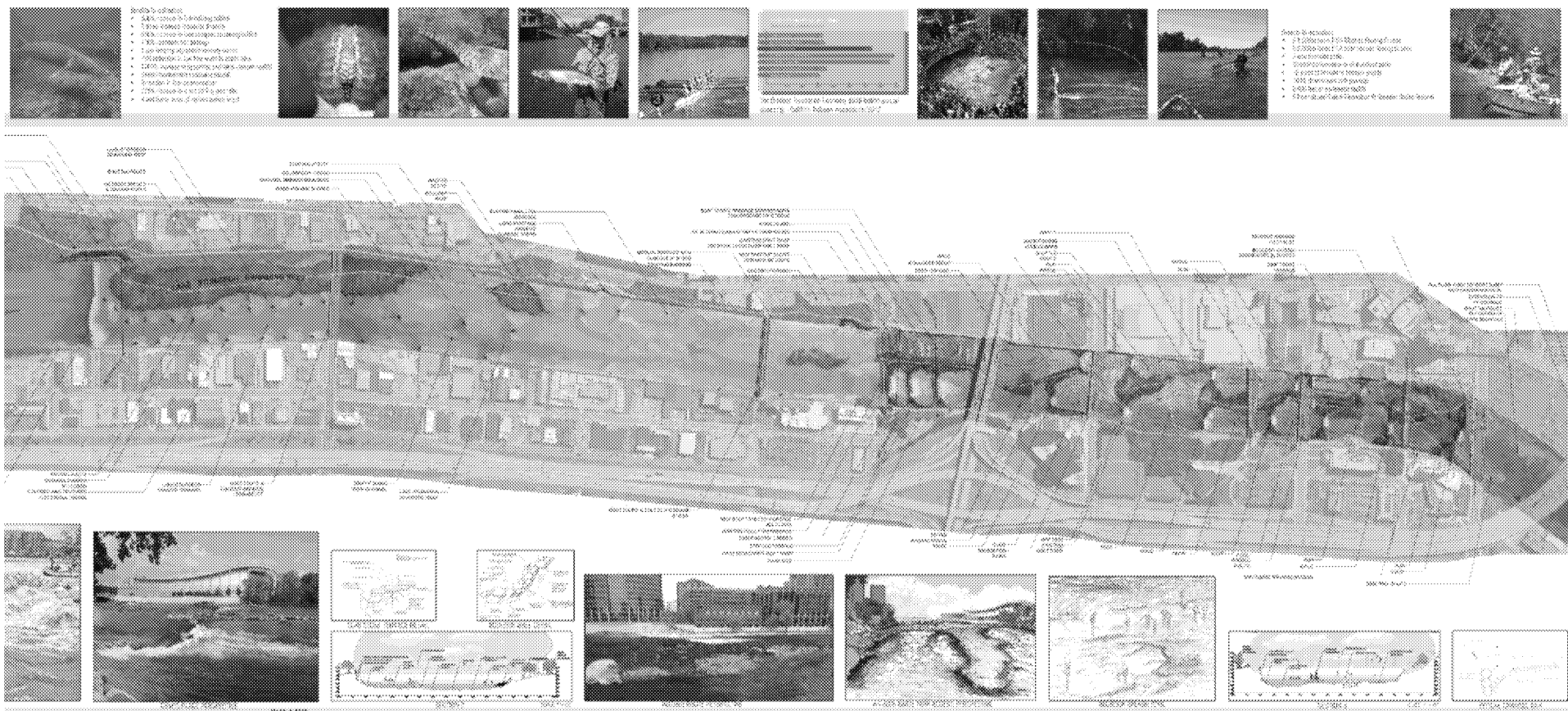


HURON RIVER, MI



FOX RIVER, WI

2013 DESIGN BANNER

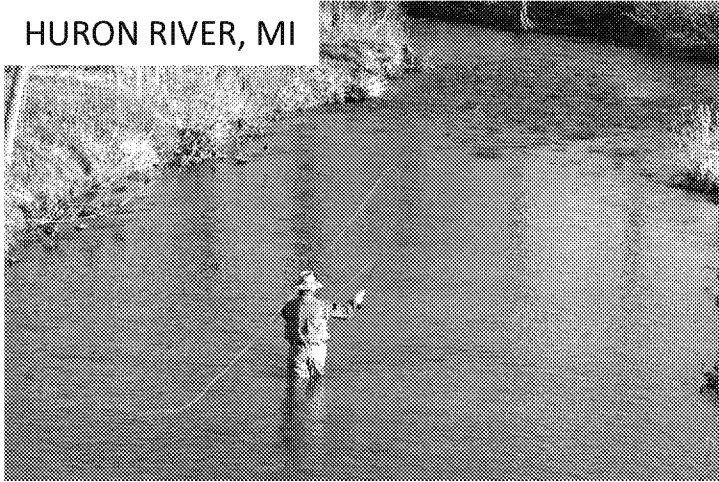


Hydraulic Design Elements

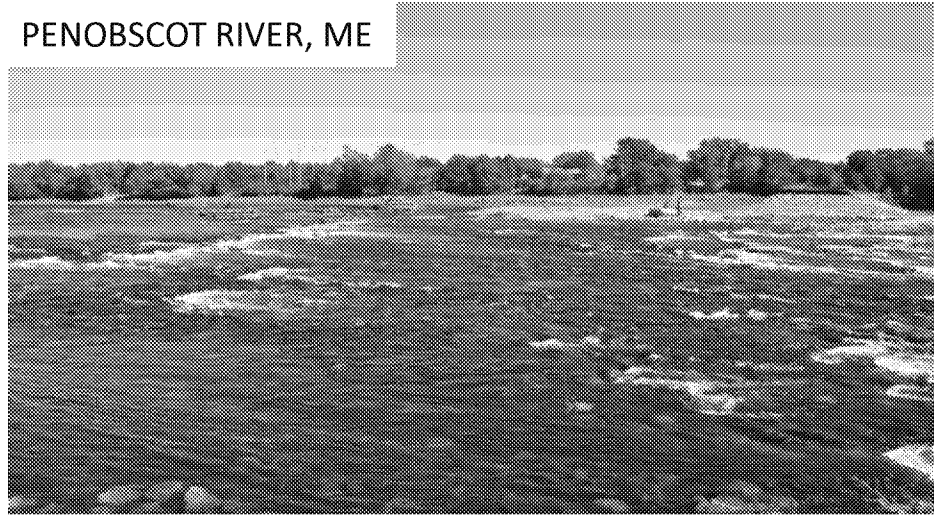
Riffle Feature

- *max headloss: 18 inches*
- *max bed slope: 2.5%*
- *variations in grade and substrate*

HURON RIVER, MI



PENOBSCOT RIVER, ME

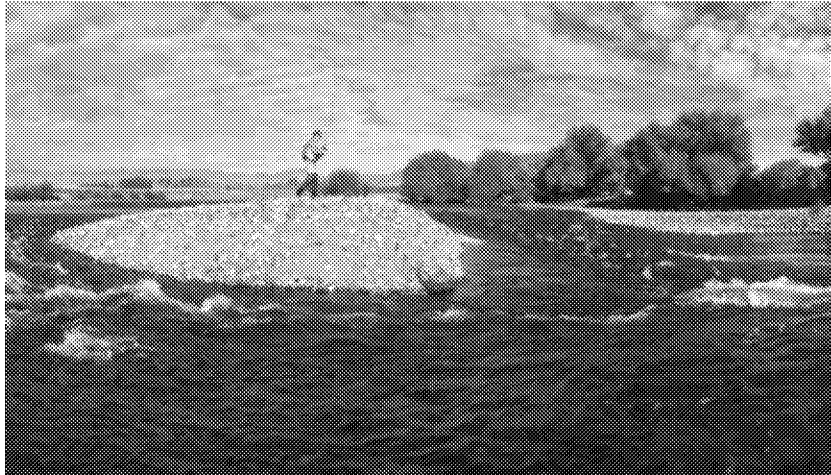


MUSKEGON RIVER, MI

Hydraulic Design Elements

Run Feature

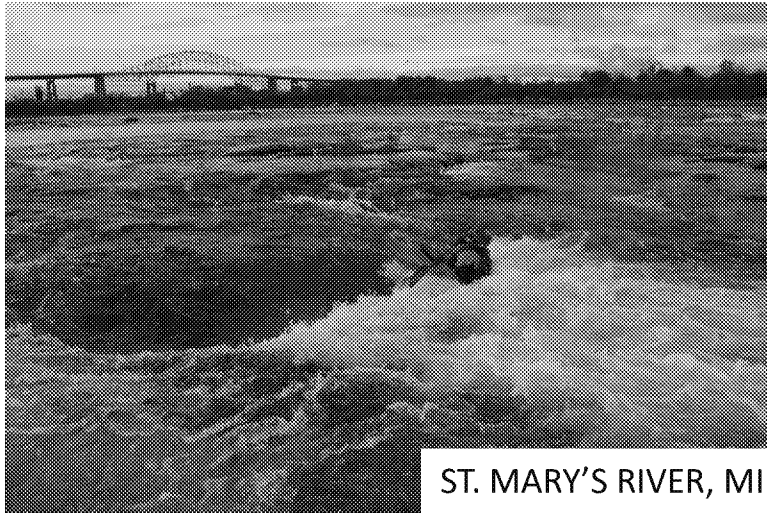
- *max headloss: 18 inches*
- *min width: 40 ft*
- *rolling waves or swift current with adjacent eddies*



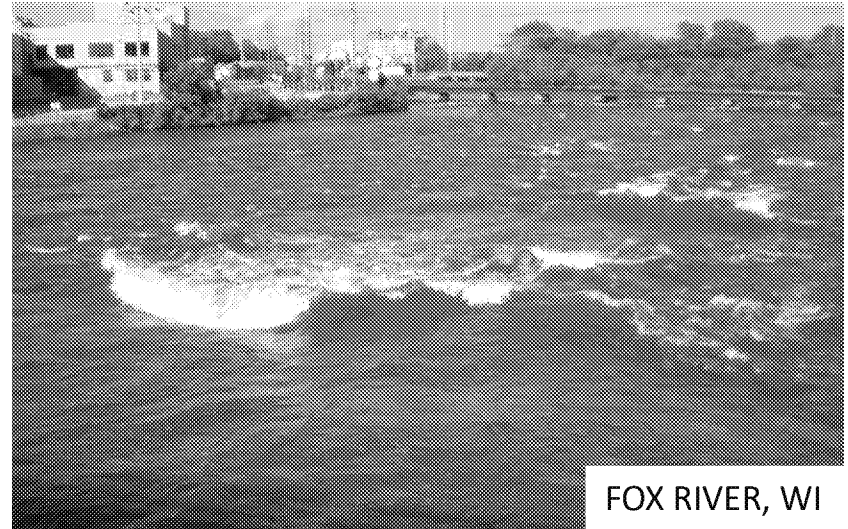
Hydraulic Design Elements

Wave Feature

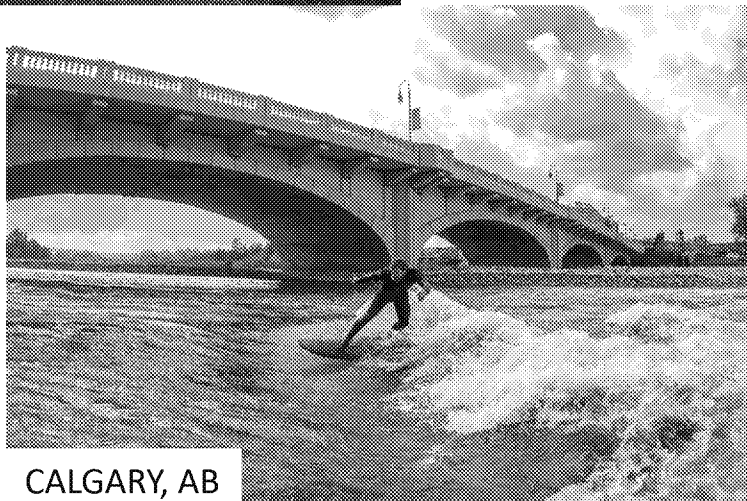
- *max headloss: 18 inches*
- *min width: 40 ft*
- *tailwater above invert elevation*
- *standing wave with adjacent eddies*



ST. MARY'S RIVER, MI



FOX RIVER, WI



CALGARY, AB



GRAND COUNTY, CO

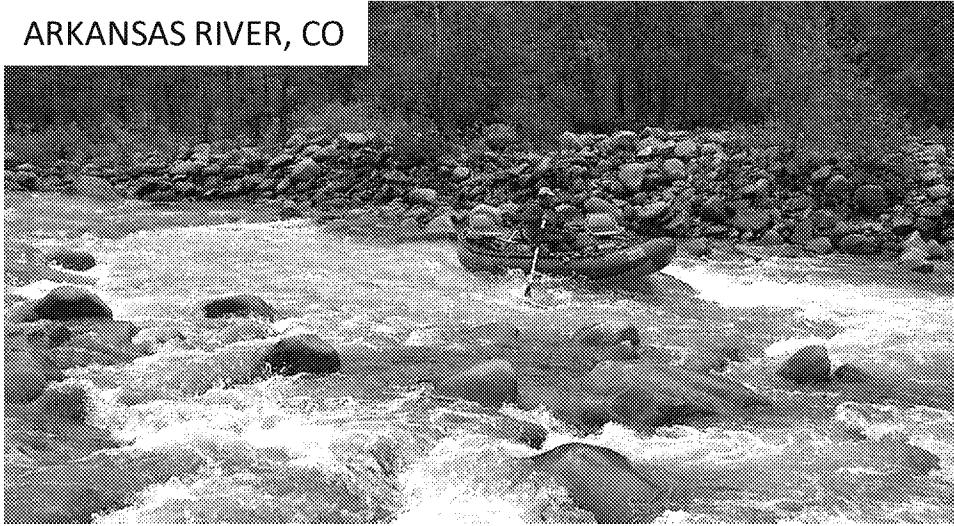
Hydraulic Design Elements

Boulder Garden

min spacing: 3 ft

top of boulder submerged at regular flows

ARKANSAS RIVER, CO



Design Modification

2014 to 2018

- Modifications to the design were in an effort to further naturalize and “soften” parts of the proposed hydraulics
 - This was done by converting wave features to riffles and runs which emulate conditions similar to Michigan reference reaches
- Safety, fishing access, circulation, and aquatic habitat complexity for fish and mussels were specifically considered in all design modifications

ST. MARY'S RIVER, MI



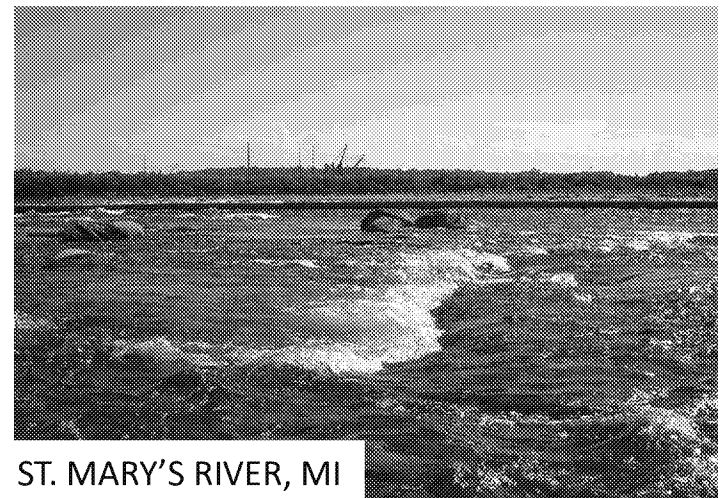
ST. MARY'S RIVER, MI



Design Modification

2014 to 2018

- Channel-spanning structures have been minimized by shifting the control locations on one side of the river either upstream or downstream
- The addition of more riffle features made of cobble and boulder to distribute the gradient on the east side of the channel
- Within the gently sloped riffle areas of the river, some larger boulder were added and the elevation of the riffle was variably graded.
 - This is in order to maintain some depth at lower flow rates and to maintain naturalized rapid functionality and aesthetic

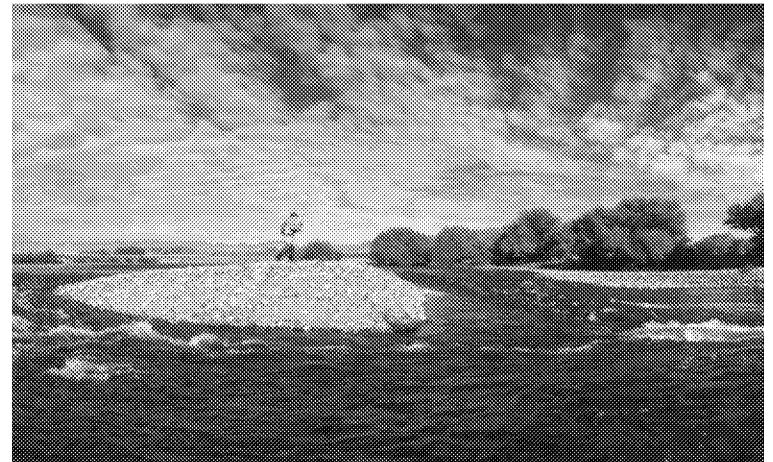


ST. MARY'S RIVER, MI

Design Modification

2014 to 2018

- Some wave features on the west side of the river were re-graded to be gradual riffles or runs
 - Specifically the features in front of the Public Museum and between Gillett and Pearl Street
 - Wave features have been reduced from 15 in 2012 to 8 in the current design
- The eight wave features that remain in the design, including the three large wave features near the dam, were diversified and reduced in width.
 - The additional area created by this reduction has been designed to be either a riffle, run, or boulder garden feature
- Diversity of flow direction was also enhanced to further naturalize the function and aesthetic of the reach



Design Modification

2014 to 2018

6TH Street Dam to I-196

- Between 6th Street Dam and I-196, the same general plan of flow distribution remained through the most recent modifications
 - However, more detail has been graded and designed throughout the reach.



Design Modification

2014 to 2018

6TH Street Dam to I-196

- Each of the passage features on the east side of the channel have been detail graded to contain a boat/tube route near the bank and a highly variable fish passage route adjacent to and throughout the bar in the channel center.
- The drops of the boat passage section have been diversified and more gradually graded than earlier iterations of design
- Maximum headloss over boat passage drops remains 9"



Design Modification

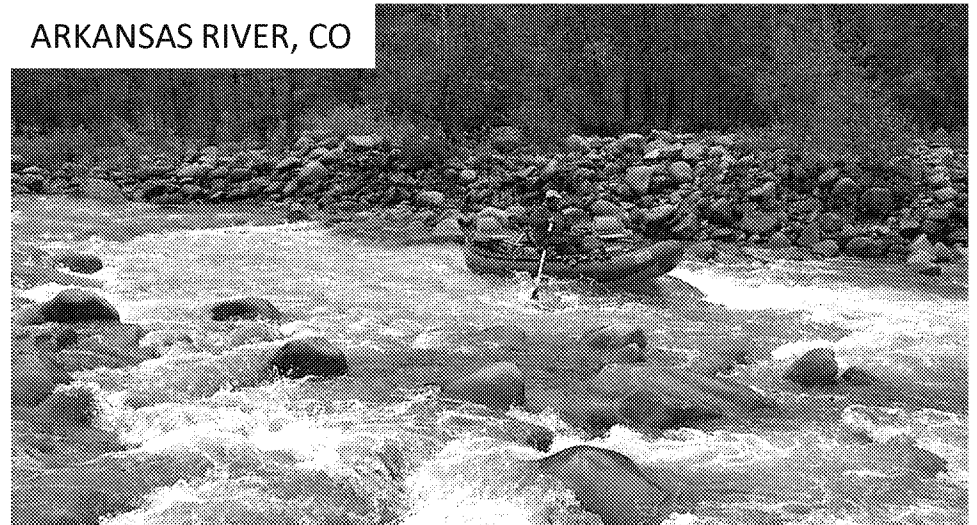
2014 to 2018

6TH Street Dam to I-196

- A higher level of grading detail has been added to the center of the channel to better evaluate and accommodate fish passage and improved habitat.
 - Less average invert elevations are shown on plans and more specific locations of changes in elevation across a given invert are detailed
 - Specific input driving these updates were in regards to providing areas of relatively deep flow with low velocities for fish passage
- Gently sloped (2.5%) cross-flow between the two sides of the channel has been added through detailed grading
 - This was in an effort to maximize fish passage functionality and the natural aesthetic of the reach



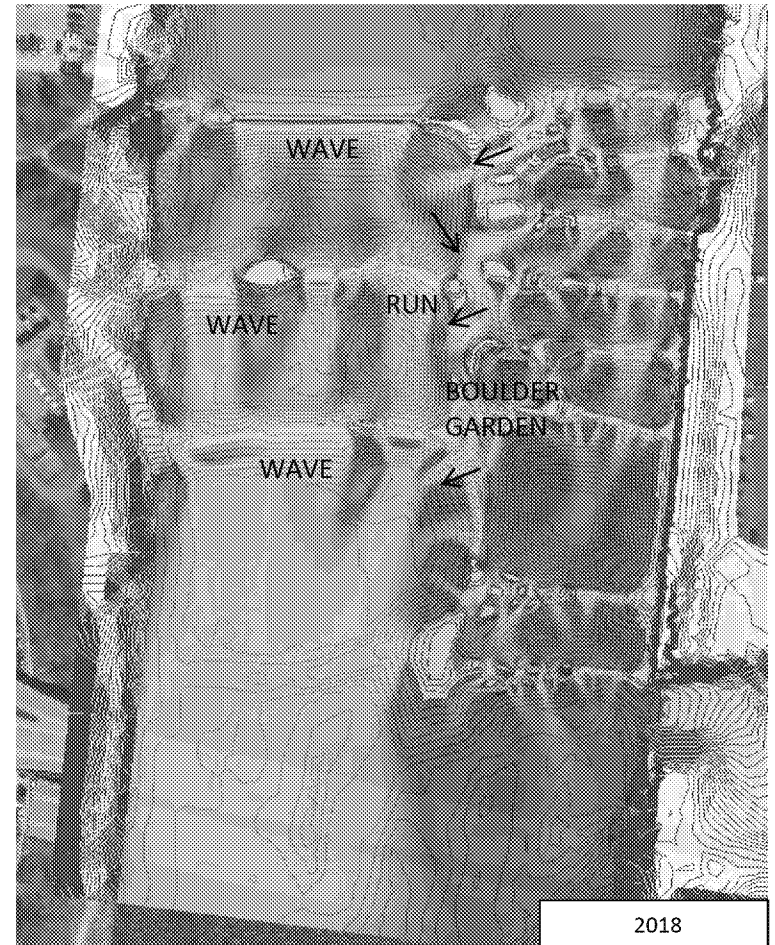
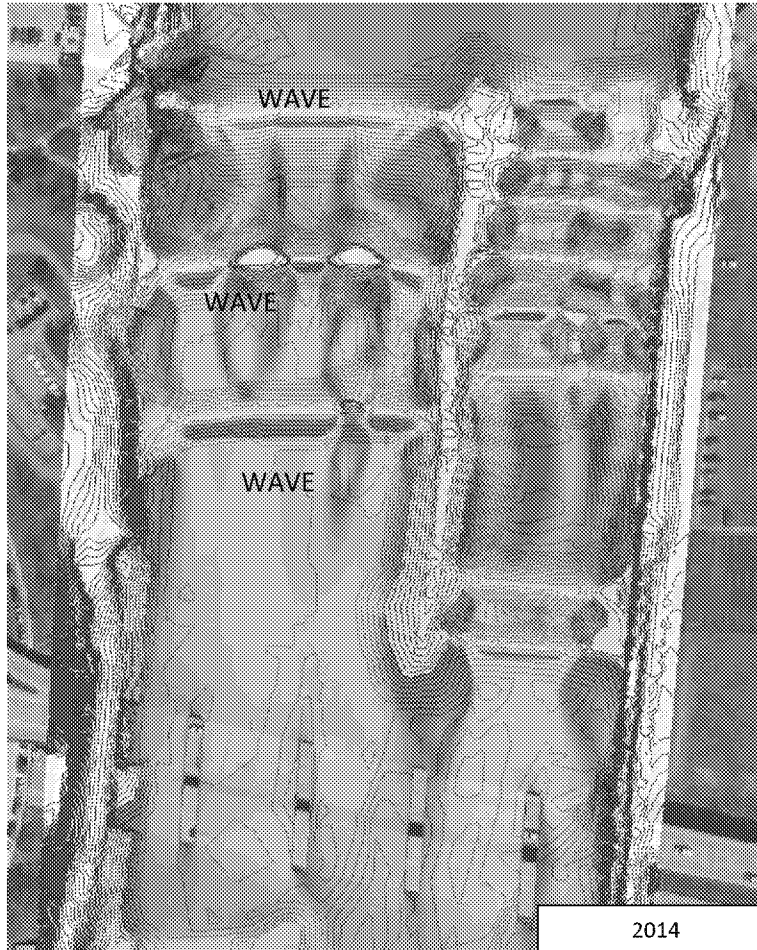
ARKANSAS RIVER, CO



Design Modification

2014 to 2018

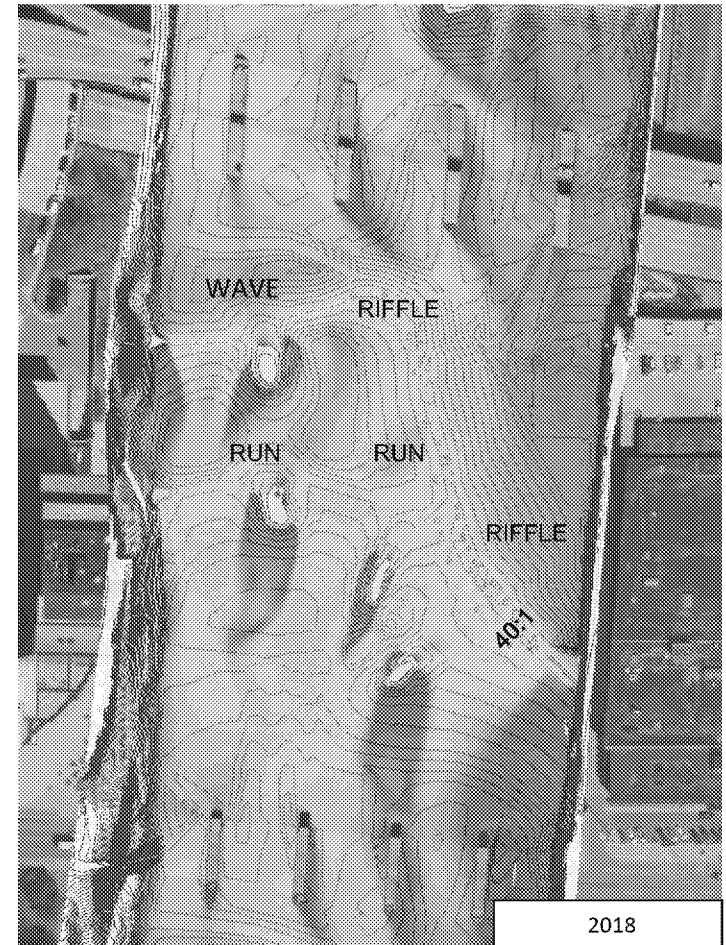
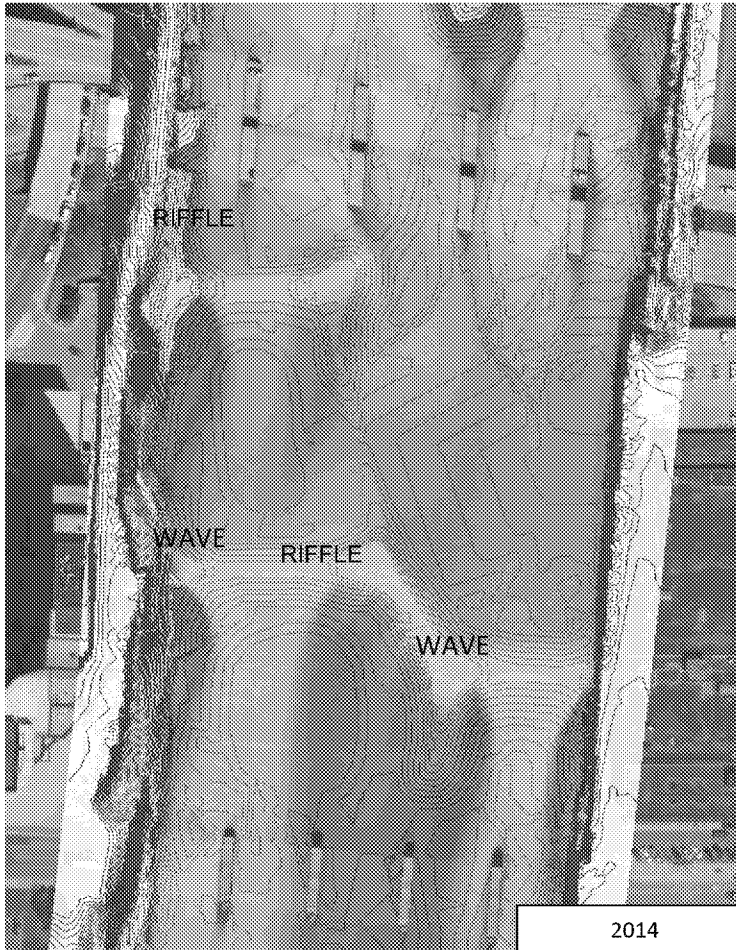
6TH Street Dam to I-196



Design Modification

2014 to 2018

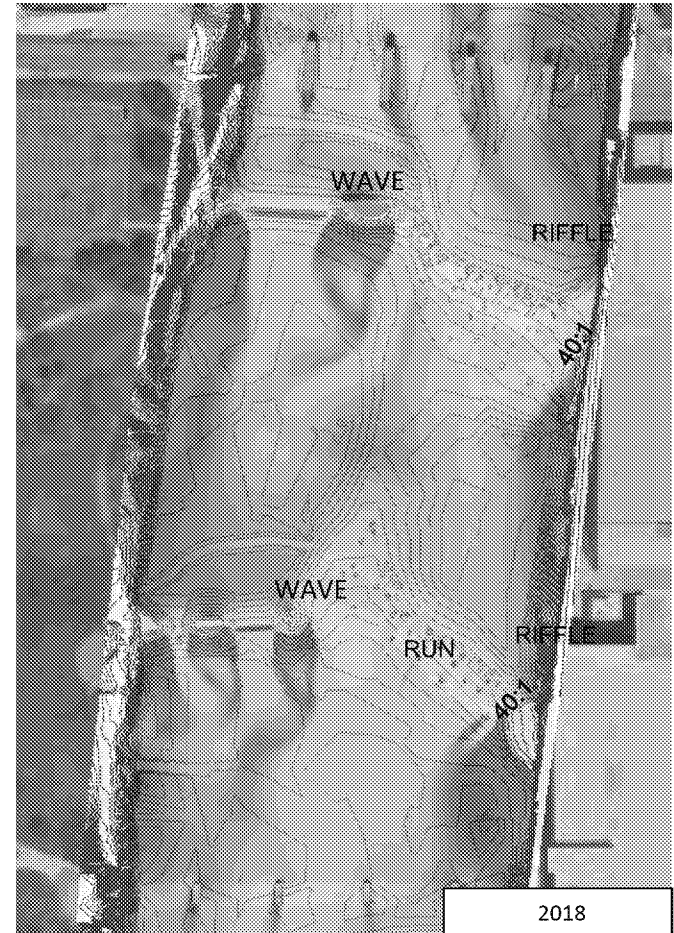
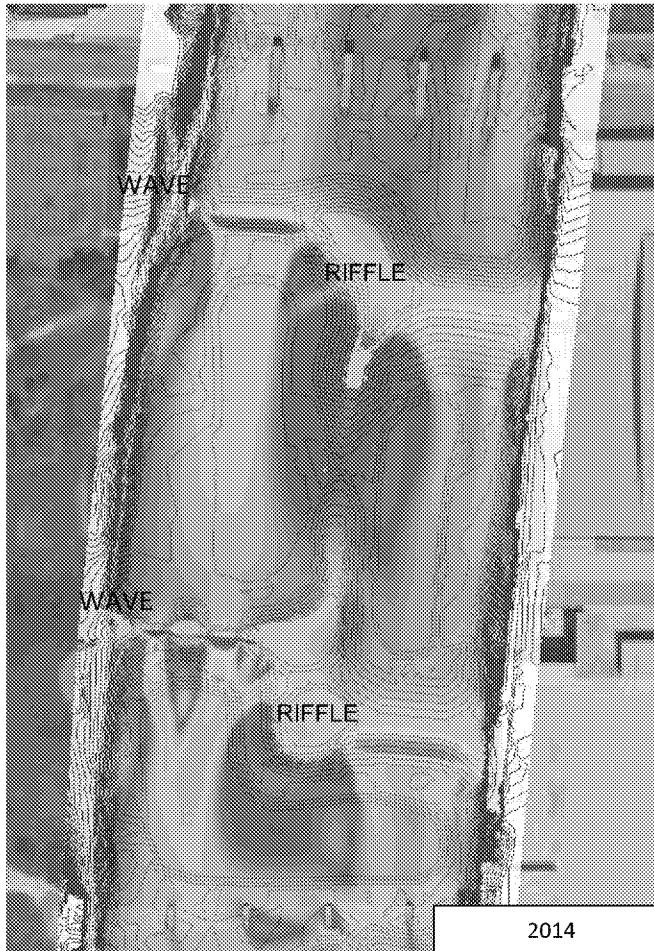
I-196 to Bridge Street



Design Modification

2014 to 2018

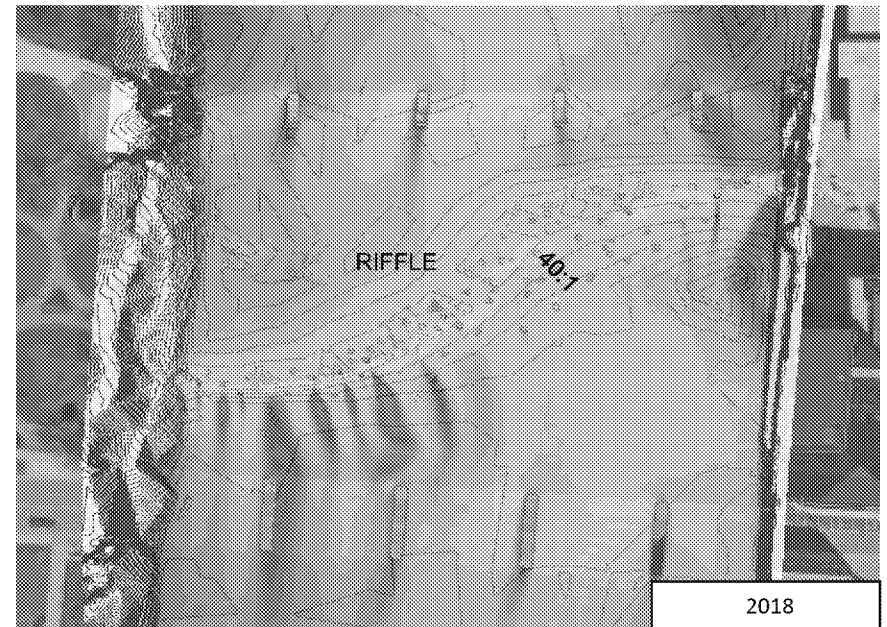
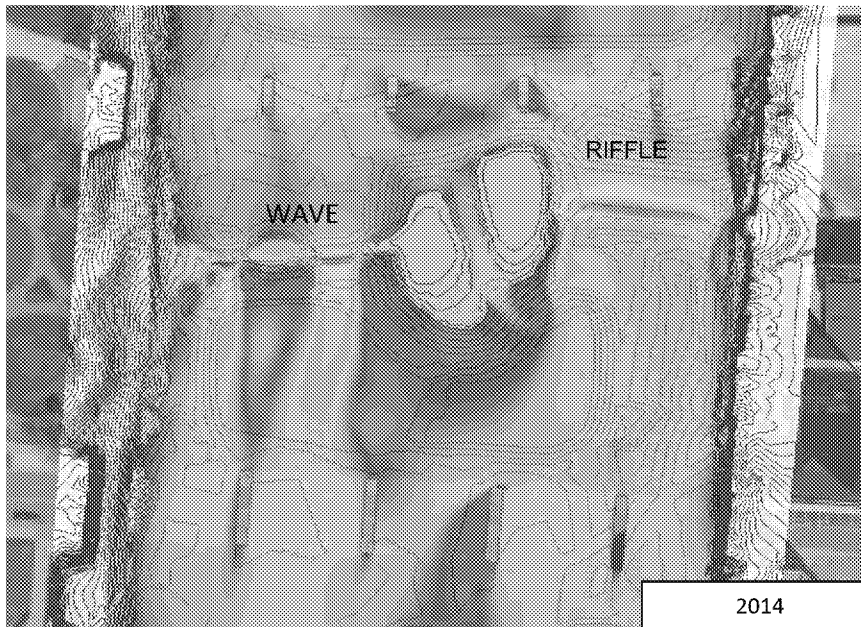
Bridge Street to Gillett Bridge



Design Modification

2014 to 2018

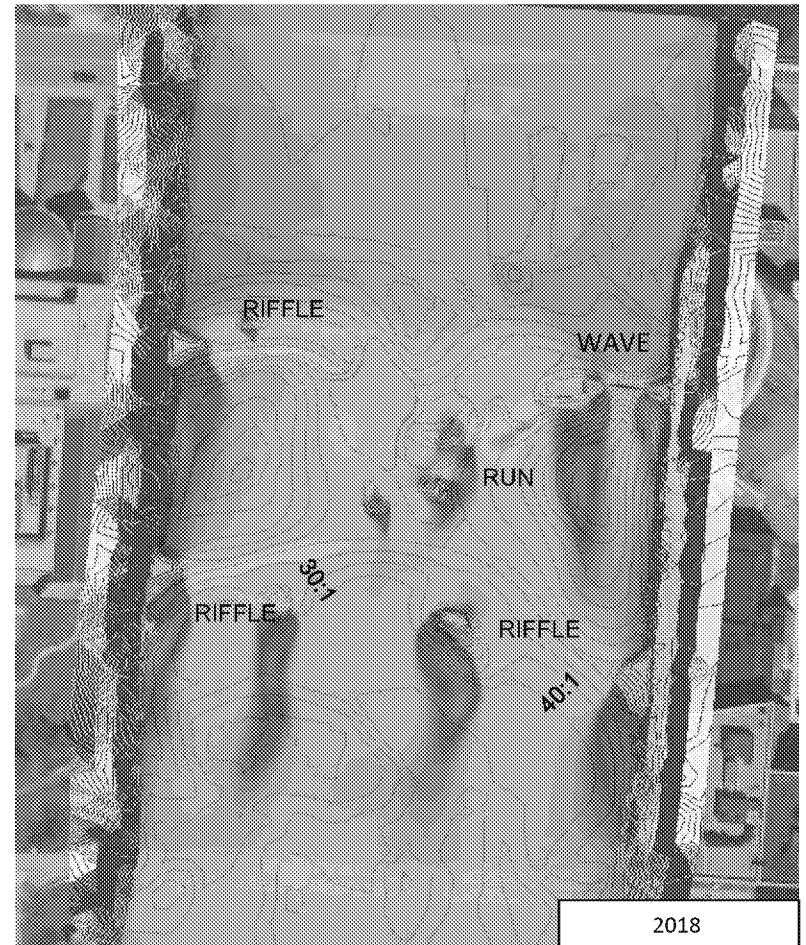
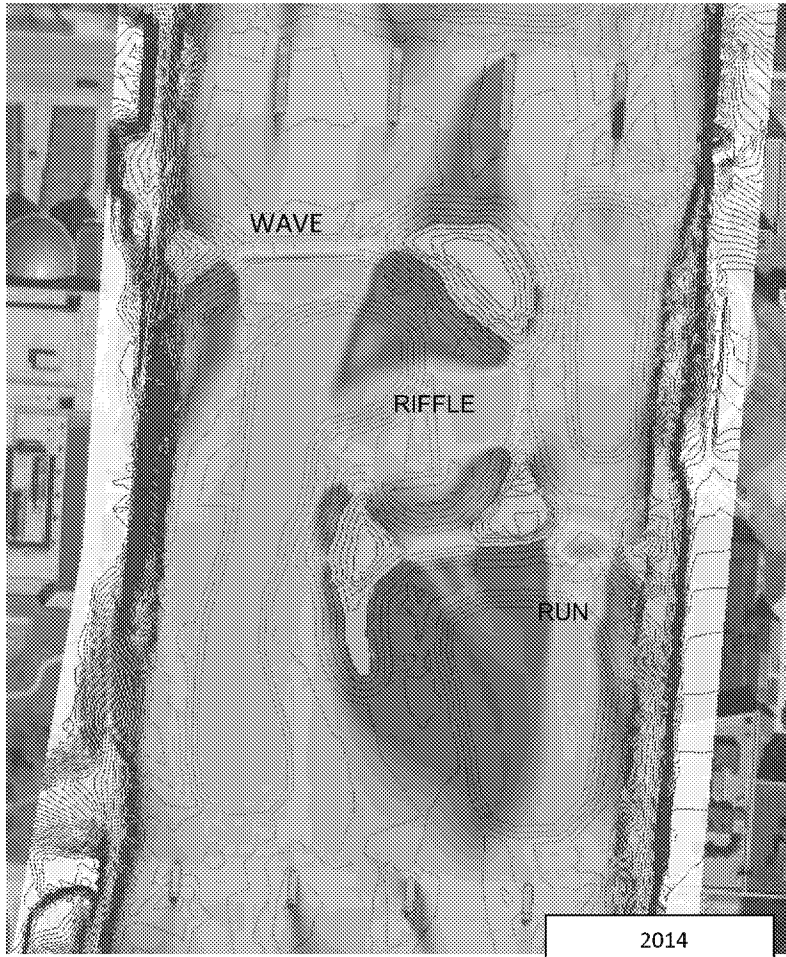
Gillett Bridge to Pearl Street



Design Modification

2014 to 2018

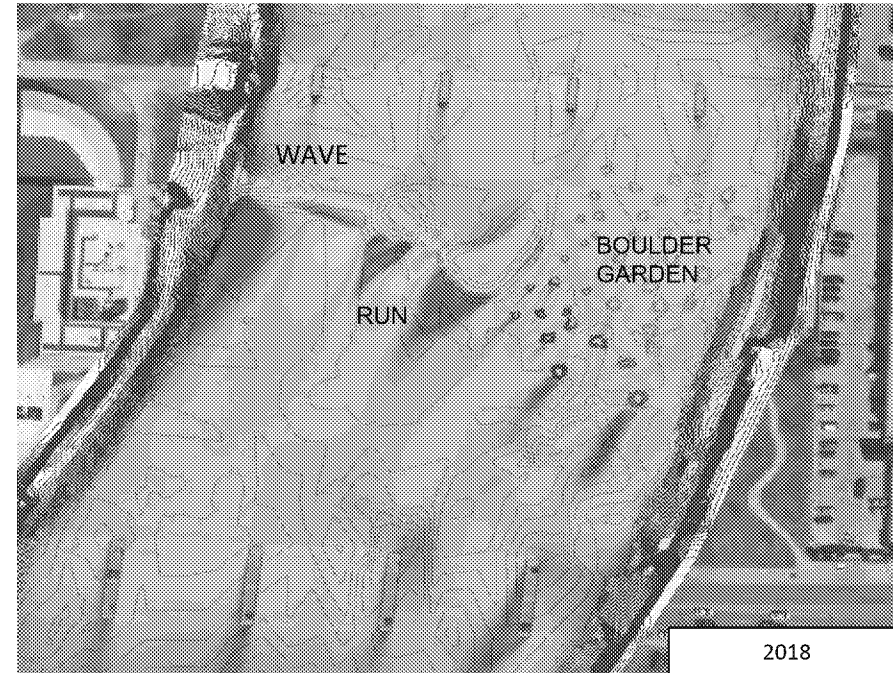
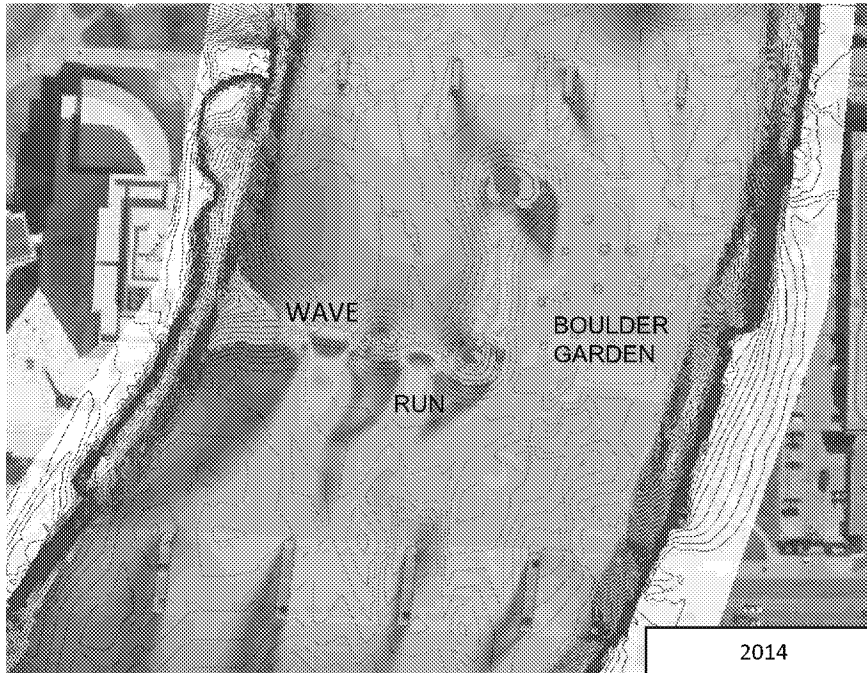
Pearl Street to Blue Bridge



Design Modification

2014 to 2018

Blue Bridge to Fulton Street



Summary

- Since 2012, there has been extensive and ongoing correspondence with GRWW, agency personnel, biologists, local fishermen, and other stakeholders regarding what changes should be made to the hydraulic design to better meet the project goals and constraints.
- Through hydraulic evaluation, design modifications have been made considering this correspondence to balance the natural function of the restored rapid-type channel for the many different users and target species
- The current design represents the most optimal balance of constraints and goals and will provide a naturally functioning rapid habitat similar to other Michigan reference reaches